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: FEASIBILITY OF DEVELOPING GROUND WATER SUPPLIE
ADJACENT TO THE GLEN CANYON NATIONAL RECREATION
AND CANYONLANDS NATIONAL PARK
WEST OF THE COLORADO AND GREEN RIVERS, UTAH

THE FEASIBILITY OF DEVELOPING GROUND WATER SUPPLIES IN AND ADJACENT TO THE GLEN CANYON NATIONAL RECREATION AREA AND CANYONLANDS NATIONAL PARK WEST OF THE COLORADO AND GREEN RIVERS, UTAH

by

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Report to

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OBJECTIVE

The purpose of this report is to identify the principal ground-water-bearing rocks in the vicinity of Hans Flat, Glen Canyon National Recreation Area, and to present a list of potentially developable ground water supplies in the area.

LOCATION

The project area includes parts of Canyonlands National Park, Glen Canyon National Recreation Area, and adjacent Bureau of Land Management land west of the Colorado and Green rivers, Utah (Figure 1).

SETTING AND GEOLOGY

Hans Flat is centered in an area of gently northwestward dipping sedimentary rocks that are deeply dissected by surrounding canyons. Elevations range from 6,600 feet at Hans Flat to less than 4,000 feet along the Colorado River and its tributaries. As shown on Figure 1, the area north of Hans Flat is drained by Horseshoe Canyon, the area to the west and south by tributaries of the Dirty Devil River, and the area to the east drains directly to the Colorado and Green rivers.

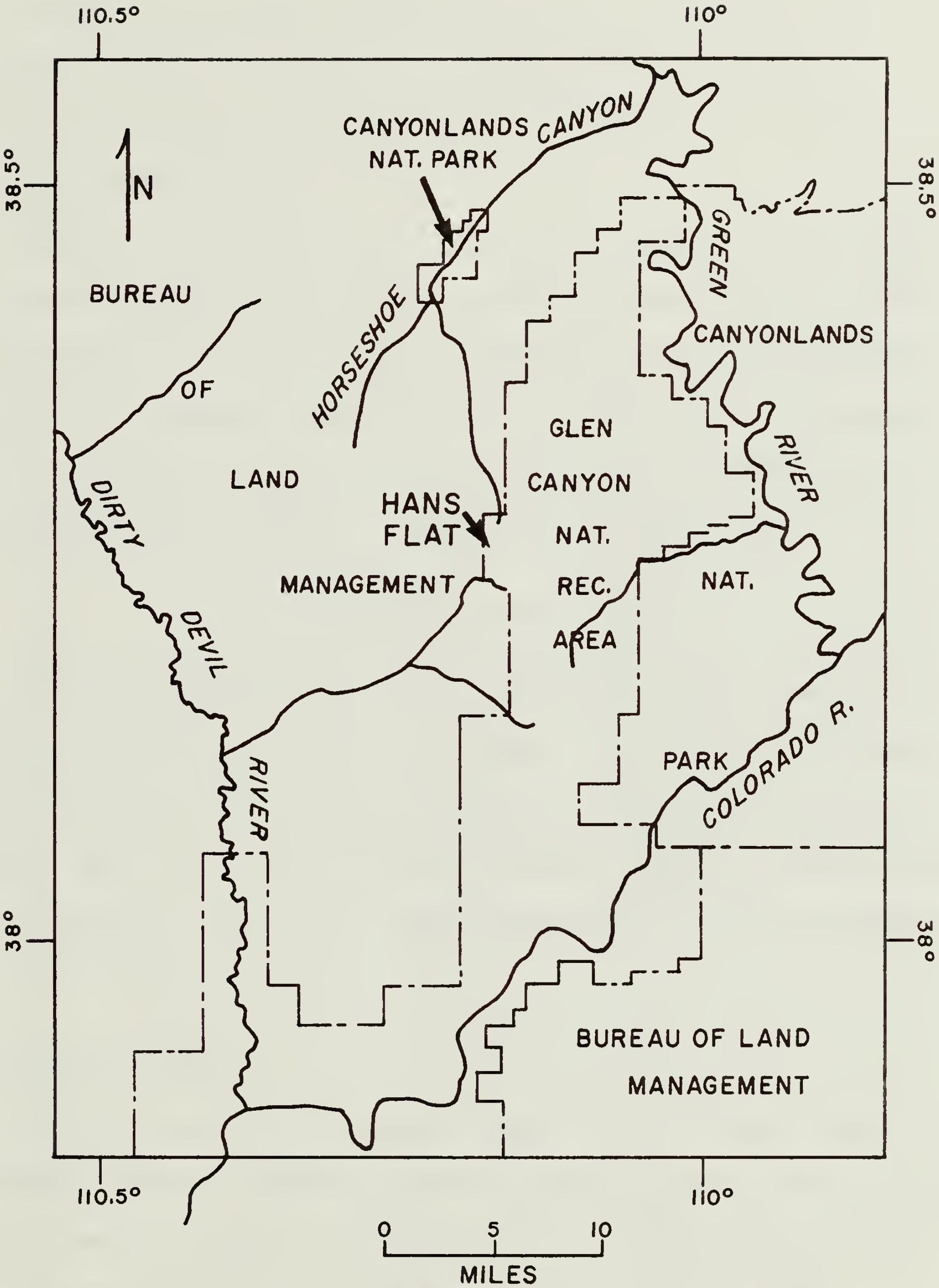

Figure 1. Location of Hans Flat, Glen Canyon National Recreation Area, Utah.

Rainfall in the area ranges upward from 6 to 12 inches with elevation (Covington and Williams, 1972). Vegetation is sparse, grading from barren slopes and grasses in the lowlands to juniper stands in the highlands.

The ages, thicknesses, and physical characteristics of the rocks that crop out in the project area are summarized on Figure 2. Stratigraphic nomenclature is from Baars and Molenaar (1971). The exposed rocks, with an aggregate thickness of over 2,600 feet, dip northwestward at an average of 100 feet/mile, and are largely undeformed by tectonic structures (Figure 3) (Williams and Hackman, 1971).

WATER-BEARING ROCKS

Two principal aquifers have been identified in the study area based on spring and seep locations (Figure 3) and observed discharge rates (Table 1): (1) the Navajo Sandstone-upper Kayenta Formation aquifer, and (2) the Cutler Formation aquifer. Secondary water-bearing rocks include the base of the Wingate Sandstone and selected permeable parts of the Chinle Formation.

Navajo-Kayenta Aquifer

The upper third of the Kayenta Formation and overlying Navajo Sandstone (Figure 2) comprise the most permeable group of rocks in the project area and respond as a single aquifer. Numerous springs and seeps discharge from these rocks as shown on Figure 3 and Table 1. Most are located in the upper third of the Kayenta Formation, or near the base of the Navajo Sandstone. Spring 2 (Table 1) in Horseshoe Canyon discharges from this aquifer and is the largest spring in the area.

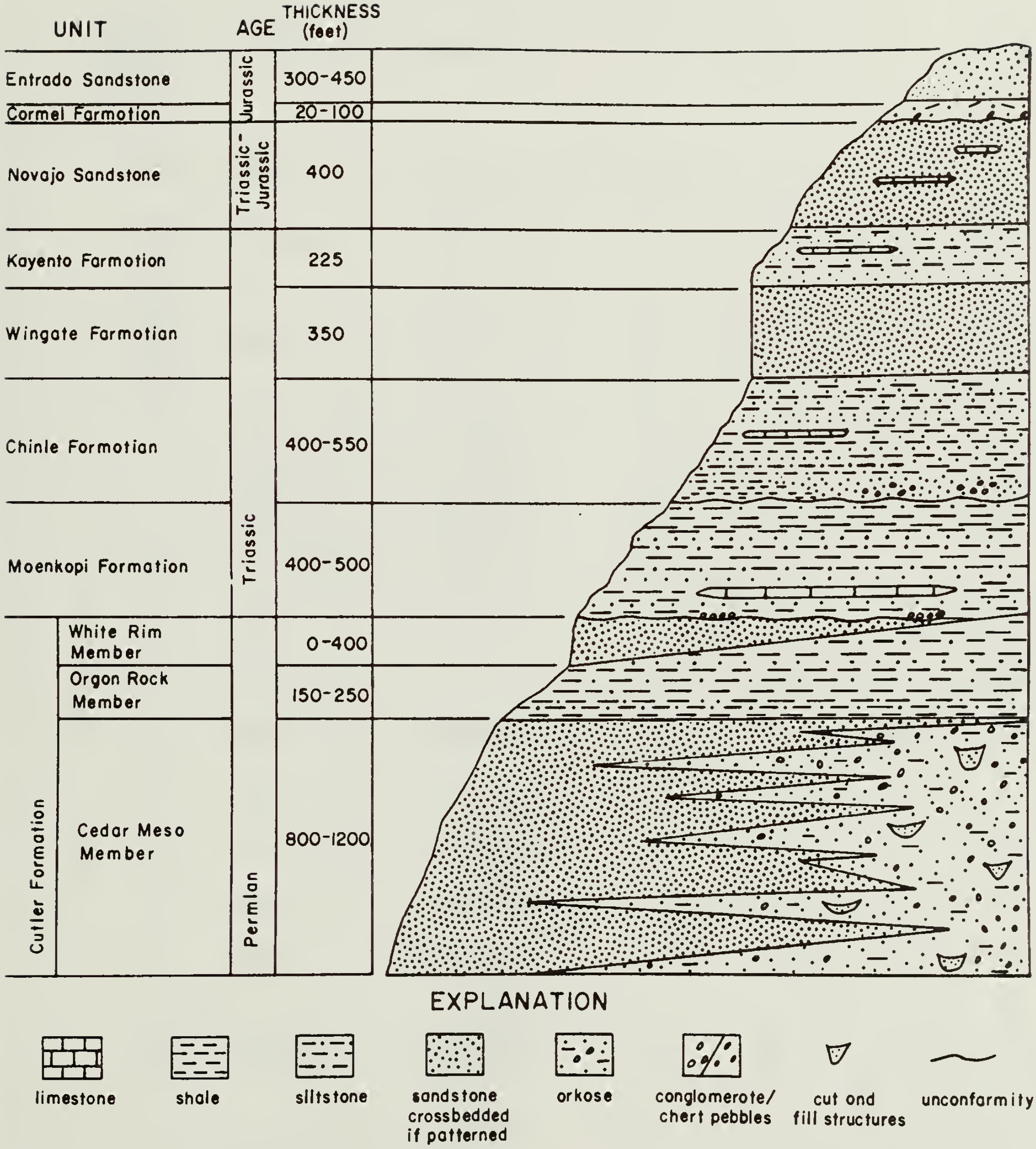

Figure 2. Ages, lithologies, and thicknesses of the rocks exposed in western Canyonlands National Park and Glen Canyon National Recreation Area, Utah.

Table 1. Chemical quality and discharge of water from selected springs, seeps, and wells, western Canyonlands National Park and Glen Canyon National Recreation Area, Utah.[a]

Spring No.[b]	Spring Name or Location	Location[c]	Date of Collection	Ca	Mg	Na	K	HCO_3	SO_4	Cl	NO_3	F	B	SiO_2	Total Diss. Solids	Hardness $CaCO_3$	Lab. pH	Specific Conductance (micromhos /cm at 25°C)	Estimated Discharge[d] (gal/min)
	NAVAJO SANDSTONE - UPPER KAYENTA FORMATION																		
1	Horseshoe Canyon	27-15-25 bad	7/10/78	31	38	17	7.8	280	38	9.0	5.1	0.3	0.0	5.4	308	230	8.1	535	seep
2	Horseshoe Canyon	27-16-4 bdc	8/01/78	27	36	17	7.6	240	67	14	3.1	0.5	0.1	8.5	246	220	8.0	521	30.0
3	Horseshoe Canyon	27-16-19 aad	6/10/78	44	25	4.3	3.0	210	22	26	1.8	0.3	0.1	14	200	210	7.6	442	0.75
4	Big Spring	27-16-35 dda	6/10/78	29	25	9.9	5.5	190	24	16	6.2	0.4	0.1	10	172	180	7.7	409	seep
5	Upper Pasture Spring	28-15-36 cad	6/15/78	49	34	9.6	3.3	320	19	23	1.3	0.3	0.0	14	274	260	8.0	556	0.08
6	Clydes Spring	28-16-1 adc	6/10/78	42	7.9	0.8	5.0	160	13	5.2	4.4	0.2	0.0	4.0	122	140	7.4	291	seep
7	Three Fingers Spring	28-16-28 cbb	6/17/78	52	8.1	3.0	4.3	190	11	11	4.0	0.2	0.0	15	160	160	7.7	357	seep
8	Wildcat Spring	29/15/13 ccd	6/13/78	53	31	7.3	2.5	300	24	8.5	0.4	0.2	0.0	12	256	260	7.9	532	seep
9	Spring No. 9	29-15-24 aba	6/14/78	33	22	4.9	1.9	200	17	8.1	2.2	0.2	0.0	6.3	164	170	7.9	377	0.30
10	Spring No. 10	29-16-19 add	6/14/78	40	23	5.8	1.7	210	25	11	3.1	0.2	0.0	9.7	192	190	7.7	426	seep
11	Spring No. 11	29-16-30 aab	6/14/78	26	18	4.0	1.2	170	11	7.8	0.9	0.2	0.0	8.4	120	140	7.9	308	0.25
12	Burro Seep	29-16-20 add	6/18/78	43	22	6.9	2.2	200	13	8.5	4.0	0.2	0.0	6.9	152	200	7.5	430	0.17
13	French Spring	30-16-3 aab	7/14/78	49	15	24	2.1	190	41	22	23	0.3	0.0	9.7	214	180	8.2	488	0.66
14	French Spring Fork Spring	30-16-4 dcb	8/02/78	36	21	11	2.2	190	34	3.7	2.7	0.3	0.0	11	208	180	7.9	414	seep
	WINGATE SANDSTONE																		
15	Horsethief Canyon	27-17-20 cbb	7/10/78	26	34	32	6.2	290	27	7.1	5.3	0.4	0.0	7.4	264	200	8.3	527	0.33
16	Horsethief Canyon	27-17-20 bbd	7/10/78	23	30	29	6.6	260	23	0.0	8.0	0.3	0.0	6.3	320	180	7.6	486	0.25
	CHINLE FORMATION																		
17	Horsethief Canyon	27-17-4 dcd	7/10/78	20	37	210	17	410	180	62	1.3	0.8	0.3	9.1	570	200	8.6	1090	0.25
18	Horsethief Canyon	27-17-20 abc	7/10/78	40	41	41	8.8	400	36	8.5	0.9	0.5	0.1	10	324	270	8.1	701	0.50
	WHITE RIM MEMBER - CUTLER FORMATION																		
19	Anderson Bottom Spring	28-17-23 bad	8/12/78	34	10	18	5.8	150	42	2.2	0.4	0.3	0.1	8.8	184	130	8.0	358	seep
	CEDAR MESA MEMBER - CUTLER FORMATION																		
20	Hans Flat Well	29-16-28 cbc	11/25/78	230	51	180	47	230	960	52	0.0	0.6	0.9	6.5	1600	780	7.5	2080	4.0
21	Horse Canyon Spring	29-18-20 ccd	7/25/78	110	58	46	10	280	380	20	3.1	0.5	0.1	12	814	510	8.0	1160	0.10

Table 1. (continued)

Spring No.[b]	Spring Name or Location	Location[c]	Date of Collection	Ca	Mg	Na	K	HCO_3	SO_4	Cl	NO_3	F	B	SiO_2	Total Diss. Solids	Hardness $CaCO_3$	Lab. pH	Specific Conductance (micromhos /cm at 25°C)	Estimated Discharge[d] (gal/min)
22	South Fork Spring	30-17-23 ccc	7/29/78	58	28	13	3.8	300	51	14	0.4	0.3	0.0	8.1	282	260	8.0	575	seep
23	Pictograph Spring	30-18-6 dbc	7/26/78	51	50	30	4.6	340	89	8.5	1.3	0.4	0.1	12	406	330	8.1	773	2.0
24	Jasper Canyon Spring	30-18-9 bbd	7/27/78	82	29	12	2.6	360	8.0	10	0.7	0.3	0.0	14.6	360	320	8.0	339	seep
25	Water Canyon Spring	30-1o-15 cca	8/02/78	74	16	26	2.1	300	49	15	1.3	0.3	0.1	7.7	322	250	7.9	595	1.8
26	Sheeper's Spring	30½-17-28 cdb	7/24/78	33	17	7.1	2.7	180	25	2.2	3.5	0.2	0.0	7.8	120	150	7.7	343	0.04

[a] Analysis by Wyoming Department of Agriculture, Division of Laboratories, Laramie, Wyoming; all analyses are in milligrams per liter.

[b] Spring location numbers correspond to numbers used on Fig. 3.

[c] Township south - range east - section - quarter section - quarter quarter section - etc.

[d] Discharge data collected on same day water quality samples were collected; seep - indicates discharge too small to estimate.

Typically the springs and seeps that discharge from the Navajo-Kayenta aquifer are small, less than 0.25 gallons/minute. In most cases, the water discharges as seeps along partings between beds that wet the surface of outcrops or creates zones of unusually dense vegetation. French Spring is the only Navajo spring that is currently developed in the vicinity of Hans Flat. When examined in July, 1978, it yielded less than a gallon/minute and was used primarily for stock water.

The water quality from the sampled Navajo-Kayenta springs and seeps is excellent, as shown on Table 1.

Cutler Aquifer

Several small springs and seeps discharge from the Cedar Mesa Sandstone Member of the Cutler Formation in the lowlands east of Hans Flat (Figure 3). Similar seeps discharge from the White Rim Sandstone Member of the Cutler Formation in the northern part of the region. The discharges from these springs (Table 1) are less than 2 gallons/minute and attest to the small recharge rates to the sandstones comprising these units.

In 1973, the National Park Service drilled the Hans Flat well to a depth of 2,750 feet and bottomed in the hole 535 feet into the Cutler Formation (Sumsion, 1974). The well was pump tested at a rate of 4 gallons/minute for 24 hours. The prepumping water level was 2,492 feet and postpumping water level was 2,706 feet. Using the equation

$$T = 2{,}000 \frac{Q}{s}$$

where:

T = transmissivity (gallons/day-foot),

Q = discharge rate (gallons/minute), and

s = water level change during the test (feet),

the transmissivity of the aquifer is estimated to be about 30 to 40 gallons/day-foot. This extremely small transmissivity indicates that the ability of the aquifer to yield water to the well is marginal. Since the well was drilled, it has been used to supply the nonpotable needs of Park Service personnel at Hans Flat.

The water quality measured from the Cutler springs and the Hans Flat well in the project area is variable. The springs in the eastern part of the area have good quality potable water and undoubted discharge waters that have infiltrated directly into outcrops in the vicinity. In contrast, the water qualities from the Hans Flat well, and Spring 21 (Table 1) in Horse Canyon are poor. The Hans Flat water was sampled by Sumsion (1974) on November 5, 1973, and by this study on November 25, 1978, and found to contain total dissolved solids of 1,720 and 1,600 milligrams/liter, respectively. In both samples, sulfate accounted for 960 milligrams/liter. Iron spontaneously precipitates from the water samples. The poor water qualities found in the Hans Flat well and Horse Canyon springs are representative of the water qualities that can be expected from deep wells drilled into the unit away from outcrop areas. These poor qualities, coupled with the depth to the unit and its small transmissivities, make it unattractive for additional testing drilling in the area.

Other Water-Bearing Units

Most of the remaining springs and seeps found in the project area discharge from the base of the Wingate Sandstone or selected permeable members of the Chinle Formation (Figure 3). As shown on Table 1, the water qualities from samples taken from these springs are generally acceptable, but the fact remains that discharges are less than 0.5 gallon/minute. Most water discharges from these units as minor seeps that barely wet the surface of the rocks. Many are detectable only by dense clusters of grass or other vegetation on the outcrops. Due to the small spring and seep discharges, these units are ruled out as viable productive aquifers in the region.

GROUND WATER CIRCULATION

Ground water circulation in the rocks in the project area is generally northward or northwestward (Hannah and Walter, 1976) toward topographically low springs and seeps in Horsethief and Horseshoe canyons, and along the Green River. Most seeps and springs discharge from downdip exposures of permeable units as illustrated on Figure 3. There are no major tectonic structures in the project area that are positioned to significantly alter the general northward flow of ground water.

The northward circulation of ground water is locally altered near canyons with south or east facing walls. In such locations, the water that infiltrates into the nearby outcrops commonly circulates toward down gradient seeps along the canyon walls. Most seeps of this type occur at the base of the Wingate Sandstone and have very small discharges.

Ground water circulating through the Navajo-Kayenta aquifer discharges through numerous minor springs and seeps distributed throughout

the lowlands tributary to Horseshoe and Horsethief canyons. All but Spring 2 (Table 1) discharged less than 1 gallon/minute during the summer of 1978, indicating that the recharge rates to the aquifer in the area are very small. Water in the Cutler Formation circulates to outcrops along the Green River in the northernmost part of the project area. Total discharge from the Cutler aquifer is undoubtedly very small.

DEVELOPABLE GROUND WATER SUPPLIES

The potential for developing even modest ground water supplies in the project area are poor for the following reasons. (1) The aquifers in the region are deeply dissected by canyons and are therefore well drained. (2) There are no favorable tectonic structures that trap or concentrate ground water in the area. (3) Recharge rates to the permeable rocks are very small, as indicated by the small total discharges from permeable zones. Consequently, I have been unable to identify a single developable ground water source in Canyonlands National Park or Glen Canyon National Recreation Area west of the Colorado and Green rivers and north of the Big Ridge (Figure 3).

The philosophy that guides the prioritization of developable sites is as follows. (1) First priority is given to springs that have known development potential based on discharges observed during the course of this study. (2) Test drilling sites of lower priority are located down gradient from large contributing recharge areas. No consideration is given to the accessibility or economics of developing the given supply. The list that follows begins with the best site.

Priority 1: Spring 2

Spring 2 (Table 1 and Figure 3) is located on the floor of Horseshoe Canyon 1 mile northeast of the detached unit of Canyonlands National Park. The spring discharges from the Navajo-Kayenta aquifer and had a discharge of about 30 gallons/minute in August, 1978. The spring is currently undeveloped. Since it is the largest identified source of ground water in the project area, this supply cannot be ignored. The hydrogeologic feasibility of developing the spring is excellent and the expected water quality, as indicated in Table 1, is good.

Priority 2: Springs 9 and 11

Springs 9 and 11 (Table 1 and Figure 3) have the advantage of being respectively 3 and 1.5 miles from the existing developments at Hans Flat. Each discharged approximately a quarter of a gallon/minute during the summer of 1978, and these flows could be increased by development work. Although the total yields from these springs are small, storage facilities could be built to allow for the development of small domestic supplies. It is my recommendation that the Park Service examine these springs to determine if they can be developed. If prospects are encouraging, the springs should next be monitored for a number of seasons to determine if yields are reliable. The hydrogeologic feasibility of developing these sites is fair and the anticipated water quality, as shown on Table 1, is very good.

Priority 3: Test Well Northwest of Hans Flat

The northern part of Robbers Roost Flats and the part of Antelope Valley shown on the Robbers Roost Canyon, Utah, U.S. Geological Survey

15-minute quadrangle overlies parts of the Navajo-Kayenta aquifer that drain substantial updip recharge areas which lie to the south. A well situated along the park access road in this area 15 miles or more north of Hans Flat has a reasonable chance of encountering developable supplies of ground water from the base of the Navajo Sandstone or upper third of the Kayenta Formation. The best well locations along the access road are those located in T. 27 S., R. 15 E. Chances for success improve toward the north because a larger recharge area is available to supply the sites.

Drilling should proceed at least 100 feet into the Kayenta Formation and typical drilling depths in T. 27 S., R. 15 E. will be approximately 1,100 feet. The primary problem with a well located in this area is the possibility that the water will contain excessive sulfates. This potential exists because much of the recharge water that reaches the Navajo-Kayenta aquifer in the area must pass through the gypsum-rich Carmel Formation. The total dissolved solids in the water should be less than 500 milligrams/liter. The feasibility of developing potable supplies from this area is only fair.

Priority 4: Test Well in the Graben, Northeast Corner of T. 29 S., R. 15 E.

The only fault zone with potential for concentrating ground water near Hans Flat is the graben shown on Figure 3 in the northeast corner of T. 29 S., R. 15 E., 4.5 miles northwest of Hans Flat. A test well located on the south side of Upper Pasture within the graben a few tens of yards southwest of the northern bounding fault has the potential of penetrating saturated fractures at the level of the Navajo-Kayenta aquifer. Typical depths for such a well penetrating the upper 100 feet

of the Kayenta Formation would be on the order of 500 feet. The chances for successfully locating an adequate ground water supply from this structure are only fair. Expected water quality is good, with total dissolved solids of less than 300 milligrams/liter based on waters sampled from the aquifer downgradient in Horseshoe Canyon.

Priority 5: Hans Flat Well

The Hans Flat well could be deepened into the Cedar Mesa Sandstone Member of the Cutler Formation at least 500 feet, with excellent prospects that additional water could be produced from the unit. It is likely that the total yield of the well could be doubled or tripled through such measures. The principal disadvantage associated with this alternative is that the water quality would be the same or worse than that in the present well (Table 1) and extensive treatment would be required to make the water potable. The probable success of such a venture must be rated as poor.

RECOMMENDATIONS

Hans Flat offers the perfect natural gateway to the western part of Canyonlands National Park; however, it is one of the most disadvantaged sites for a water supply in the area. It makes economic sense for the National Park Service to consider alternative sites for the entrance station that are more closely tied to an available water supply. Feasibility for a facility improves toward the north end of Robbers Roost Flats along the park access road where ground water could be developed in accordance with technical priorities 1 or 3 identified in this report. The major disadvantage of this plan is that the facility would lie off park lands.

The economic feasibility of developing ground water supplies for use at Hans Flat is poor. If modest facilities continue to be operated at Hans Flat, I would recommend that the Park Service examine the feasibility of using rain catchments for their required potable supplies, and supplement this water with the nonpotable water available from the Hans Flat well as long as the well continues to function.

ACKNOWLEDGMENTS

The data in Table 1 and Figures 2 and 3 were prepared by Forrest Hand, Master of Science graduate student, Department of Geology, University of Wyoming, as part of his M.S. thesis project. George Billingsley provided expertise on the stratigraphy in the area.

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FIGURE 3